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VOL. III.

NEW YORK, SEPTEMBER, 1898.

No. 7



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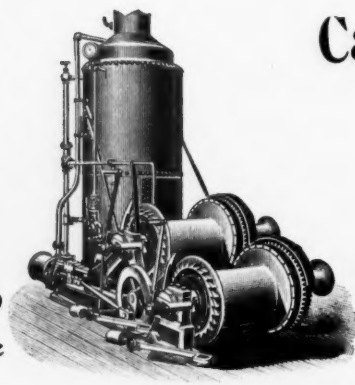
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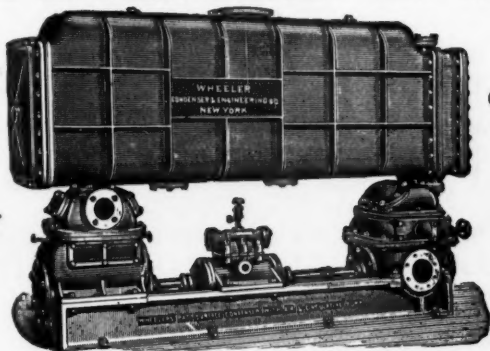
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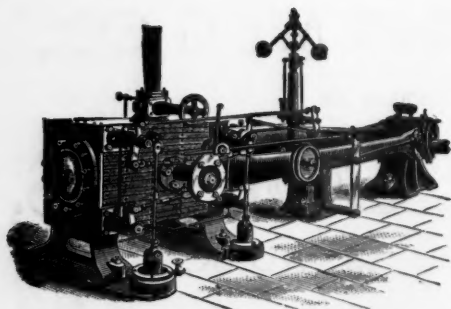
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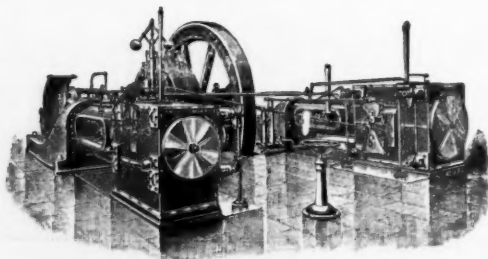
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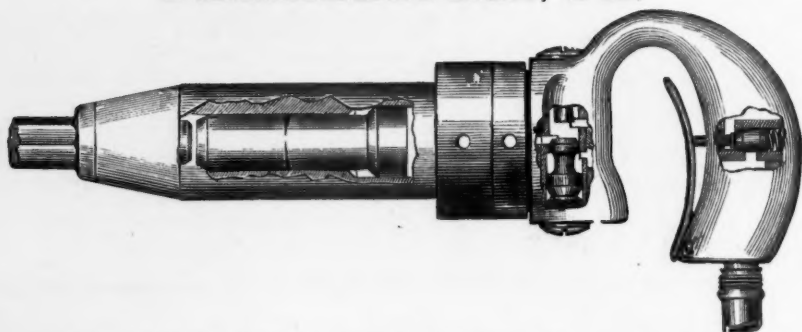
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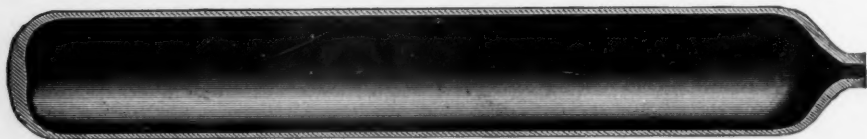
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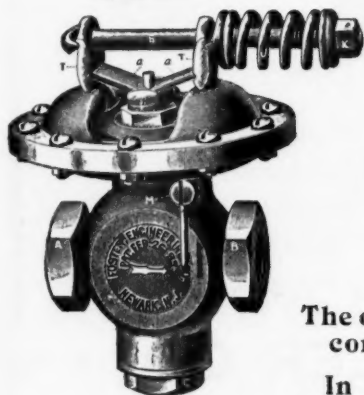
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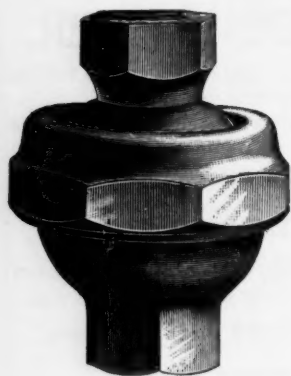
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The importance of reheating compressed air is as yet but little understood. Theoretically, reheating offers great economical advantages; practically, these advantages have not been attained, largely, we think, because of the lack of experience. There are, of course, limitations to reheating; it is not practical, for instance, to use dry, hot air in the cylinder of an engine at temperatures much above 350°, but even if the air is heated to 300° and used at that temperature the increase in volume which this effects under constant pressure is large and important. Under normal conditions, say at 60° temperature, air reheated to about 300° will be increased in volume nearly fifty per cent. It has been claimed by engineers who have tested reheaters applied to pneumatic motors, that a storage tank of given volume and pressure has been used to propel a car $3\frac{1}{4}$ miles with cold air, and at the same volume and pressure when used with heated air, the car was propelled $6\frac{1}{2}$ miles.

We recall a personal experience last year during the tests of the Hardie motor on 125th street, New York: a car which had been making three trips with a single storage of air was unable to make but two trips, when it was discovered that the steam which was used at the terminal station to reheat the storage water on the car had so far run down in pressure, that notwithstanding the fact that the hose had been coupled to the tank as usual, yet the water received only a part of the accustomed temperature. This was not discovered because the motor-man omitted to keep a record of the initial temperature at the charging station.

It has been shown by figures and is claimed by those of experience, that the cost in heat units of the increased volume of air produced by reheating is from one-sixth to one-eighth of the cost of an equal volume when produced by the process of compression.

In connection with this subject the following letters are interesting as pointing to a practical system of reheating first used, we think, by Mr. Rix on the Pacific Coast. The availability and simplicity of this system are apparent, though it can hardly be claimed that this is the most economical method of reheating compressed air. It is obvious that there must be the usual loss of heat units up the flue of the boiler, which should not take place in the same degree where reheaters are employed which are specially designed for the purpose. We will be glad to hear from our readers in criticism and comment on Mr. Rix's system of reheating. What is very much needed in this line is a record of practical experience,

CALIFORNIA EXPLORATION LIMITED.

San Andreas, Cal., June 8, 1898.

Editor COMPRESSED AIR :

I am just in receipt of the May-June number of your journal, and have read with much interest the article on Compressed Air Motors. I am particularly interested in what the writer says in regard to heating, since that is a matter of much importance with us, and I venture to ask if any facts were determined in these experiments which would bring into question the efficiency and desirability of the plan recently followed by E. A. Rix, at the Jumper Mine, of passing the air through the steam dome, or *above* the water line, of an ordinary boiler. This plan seems to be satisfactory where a boiler is already in stalled. The consumption of fuel is low—about $\frac{1}{2}$ cord wood per 24 hours, for 100 H. P., and there would seem to be no reason to fear any of the difficulties due to passing the air *through* the hot water.

W. L. HONNOLD.

San Francisco, June 22, 1898.

Editor COMPRESSED AIR :

In any stationary boiler of a reasonable capacity there is no danger at all of the compressed air admitted to the boiler carrying water over into the engines, or in other words, priming the boiler.

I failed to see any difference in the actions of the hoisting engine at the Jumper Mine, whether I introduced the air into the boiler through the blow off and mud drum or whether I introduced it in a pipe through the steam drum down to within about six inches of the surface of the water, but the action on the boiler was very marked. When I introduced the compressed air through the mud drum and allowed it to bubble up through water into the steam space, it vibrated the boiler to such an ex-

tent that I feared the setting of the boiler would be injured. In fact, if I had continued to run the plant another day I would probably have cracked one of the boiler walls, so I introduced the steam through the steam drum, and brought it down so that it impinged upon the surface of the water, and I noticed no different results as far as economy was concerned.

The hoisting engine is a 75 H. P. hoist, having double 10 x 12 engines, hoisting from a depth of 700 feet, and handling sufficient ore, waste, men and timbers to operate a 20 stamp mill. The fuel used in reheating is eight cords per month of pine wood.

As far as economy of reheating is concerned, dry reheaters give a greater economy than the wet reheaters, that is, if you take into consideration the fuel which the heater absorbs, but I generally advocate wet reheating, that is to say, using a steam boiler, especially if there is a boiler already installed, for if excessive work should be thrown upon the compressor, or an accident should happen to it, steam is already on the boiler and it is only necessary to throw in additional fuel and the plant can be operated with steam.

In general mining work I find that no matter how carefully a plant may be designed, there comes a time when it is necessary to shut it down, for a short period at least, to put in new brasses for the connecting rod to perhaps repair something which has been unavoidably broken, and it is at this time that the steam reheater pays for itself, and its perhaps inferior economy to dry reheating.

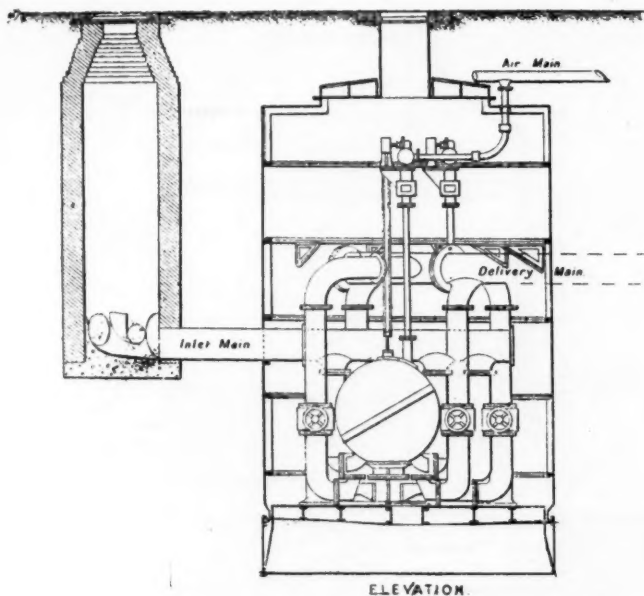
RIX ENGINEERING & SUPPLY CO.
Per E. A. Rix.

Norwich Sewerage Works.

Owing to its configuration and geological conditions it has been a matter of some difficulty to provide Norwich with an efficient system of sewerage, and some of the most eminent engineers of our time have been consulted and engaged in trying to drain the city effectually. Up to the year 1865 the city was drained by over 300 different sewers, all of which delivered

to be erected. These works were carried out in 1871.

The difficulties in constructing the main deep outfall sewer were, however, very great, and when completed it was found to be so leaky that the quantity of water pumped at the Trowse pumping station was 5,000,000 gallons per day, or just twice the ultimate quantity provided for by Sir Joseph Bazalgette. The cost of pumping thus became very heavy, the coal consump-



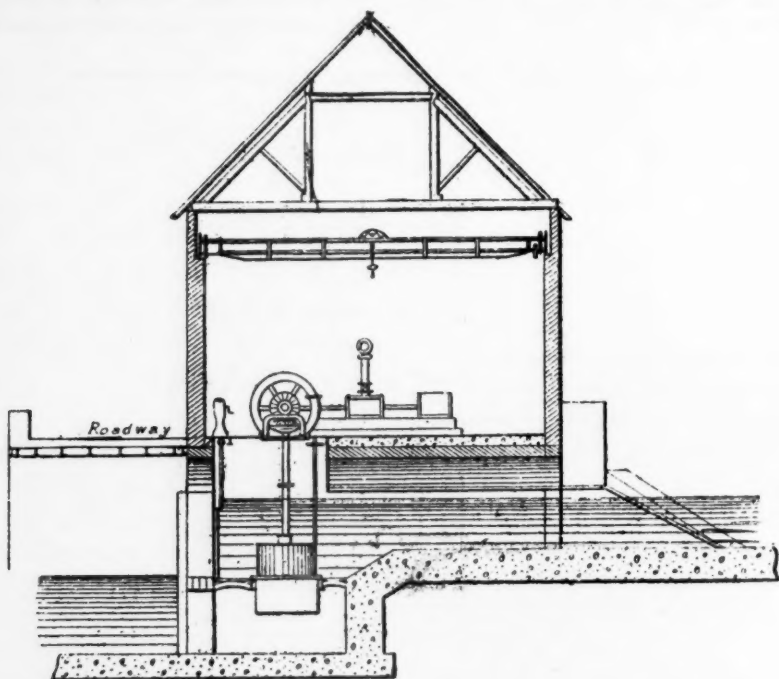
their contents into the river Wensum, with the result that it was polluted to an alarming extent. At this period the late Sir Joseph Bazalgette was called in to prepare a scheme for the drainage of the city. He proposed a deep main sewer on the southern side of the river, into which all the tributary sewers from both sides of the river were to discharge by gravitation to the outlet at Trowse, where the main pumping engines, which were to be capable of lifting $2\frac{1}{2}$ million gallons of sewage per day to the sewage farm at Whittingham, were

tion being about eight tons per day.

All the attempts made to render the leaky sewer water-tight by lining it with cast iron tubing, &c., proved futile, and in 1887 the Corporation, on the advice of Mr. P. P. Marshall, the then city engineer, decided on:—(1) The construction of a new main outfall sewer at a higher level than the old one, and the abandonment of the old one. (2) The adoption of the Shone system for raising the sewage of the low-level districts into the new main outfall sewer. (3) The redrainage of the whole of

the city on the separate system. The air required for working the ejectors is compressed by means of the water power which is available in the river Wensum at the New Mills, where formerly two under-shot water wheels were worked, but which only gave about five horse power each. The water-power now works two Victor turbines, which give 40 to 50 brake horse-power each, one of which is sufficient to

of cast iron tubing, sunk below the level of the street surfaces. These chambers or stations were sunk in the same manner as cast iron cylinders used for bridge foundations are sunk. The bottom parts of the castings are provided with a strong cutting edge, to facilitate the work of sinking them. The soil was excavated from the inside of the pits sunk to contain them, and wherever necessary it was removed



compress all the air for operating the various ejectors required to drain the low-lying parts of the city. The New Mills belong to the town, and as flour mills they were let to tenants for a mere nominal rent. By thus utilizing the Wensum river water, the working cost of the motive power for raising the sewage from the low-lying area becomes practically inappreciable. The ejectors at all the stations are in duplicate, and are placed in chambers

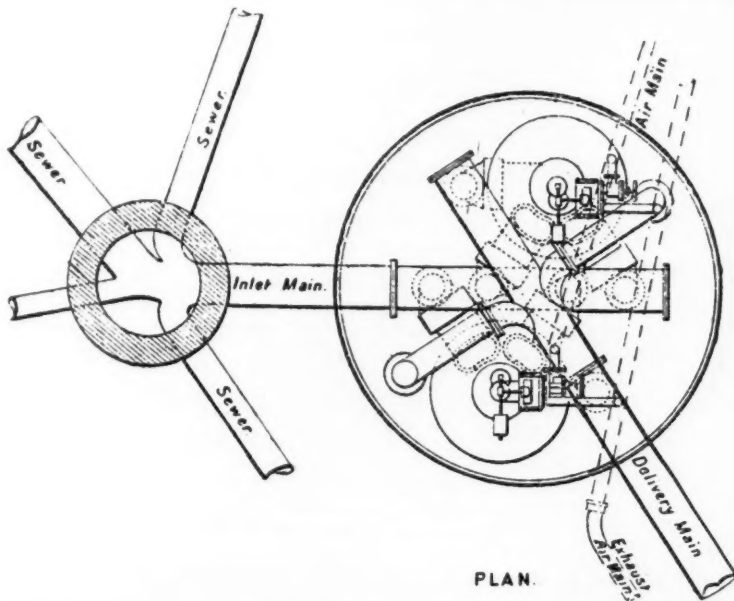
under air pressure, the entrance tube to the chamber being provided with an air lock. Heavy pumping, which might have proved destructive to adjoining properties, was thus avoided, and no difficulty was found in sinking the chambers in the water-logged subsoil to their proper depth.

The ejector stations Nos. 2, 3 and 3A discharge into one of the inverted syphons which starts in Duke of York street, just above Bishop's Bridge, goes along River-

side avenue, under Foundry Bridge, along Prince of Wales street, Rosslane and Mountergate street, and finally debouches into the main outfall sewer in King street. All the sewage from the Thorpe district is discharged into this syphon through the sewers in Bishop's road, Gas Hill, Rosary road and Thorpe road. These four roads rise steeply from Duke of York street and Riverside avenue, and four cast iron branches from the syphon pipes are carried up the roads to a manhole situated

gallons capacity in Magdalen street, which receives the sewage from part of the Catton Ward, and discharges it through one of Shone and Ault's full-bore flushing syphons every time the tank is full, thus sending a powerful current through the syphon pipe day and night.

The population of the gravitation area draining to this syphon pipe is 25,180; that of the ejector district 12,026 inhabitants. The syphon pipe passes from Magdalen street, through Fye Bridge street, under the Fye Bridge, along Wensum street and Tombland to the main outfall sewer in Prince's street. Ejector station No. 5 dis-



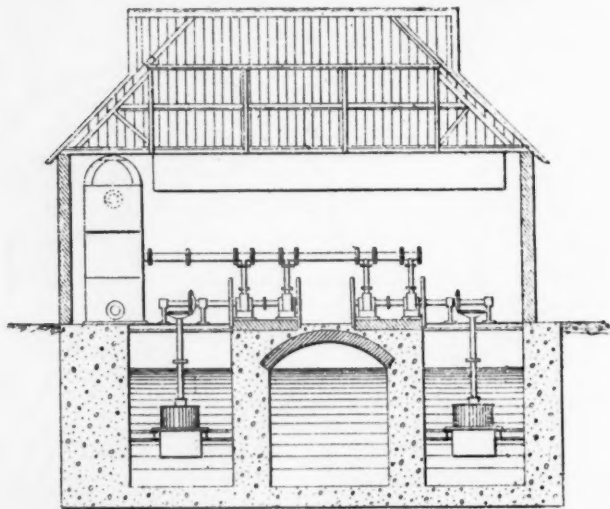
above the hydraulic gradient of the syphon pipe. The population of the gravitation area discharging into this syphon is 4780, and of the ejector area 5735 inhabitants. Ejector station No. 4 discharges into a second syphon, which conveys the sewage from the northern part of the city, viz., the Noncehold and Catton Wards, through three branches from St. Augustine street, Magdalen street and Bull Close street, meeting at Stump Cross in a 21-in. pipe, which is increased to 24-in. at the ejector station. This syphon pipe is flushed at frequent intervals from a flush tank of 3000

charges direct into the outfall sewer in Benedict street, through an 18-in. main passing along Lower Westwick street and St. Margaret street. The total population of the area drained by the ejectors is thus 39,911 inhabitants, and an additional area with a population of 29,960 inhabitants is drained through the inverted syphon pipes. The whole of the sewage goes, as already stated, through the new outfall sewer to the Trowse pumping station, where it is lifted to the sewage farm by means of large beam pumping engines.

To ascertain the available water power at

the New Mills, the water in the river Wensum was measured on May 9th, 1893, after a long period of dry weather. The mean sectional area of the river just above the Mills was found to be 0.80 per cent. of this, and the velocity 0.05256 ft. per second. The quantity of water per minute was therefore 57,700 gallons. The fall at the Mills is 6 ft. 6 in., and the total power of the water is therefore 113.6 horse power. The old wheels barely gave out 10 per cent. of this power, and the engineers therefore proposed to have them removed, and to put down a pair of 48-in. Victor turbines. These turbines have been used extensively in the United States and Canada, and they have recently been used for a large electric

During heavy floods in the river, the total water below the mill rises to the level of the ordinary head water above, and then all the sluices must be opened to avoid the flooding of the upper parts of the town and the western suburbs. On such occasions there is no available water head for working the turbines. Provision has therefore been made for driving the air compressors by steam by attaching compound steam cylinders to the tail rods of the air-compressing cylinders. The steam cylinders are 9½ in. and 14½ in. diameter, and arranged in such a manner that they can be readily connected up when a flood occurs. Steam is supplied to work the compressors from a Babcock and Wilcox



installation at Worcester, where they have given excellent results.

The Victor turbine is very simple in construction, strong and easily regulated. It gives nearly as high an efficiency with a greatly reduced gate opening as when working full power, and all the various parts are made to standard gauges, so as to be interchangeable and easily replaced.

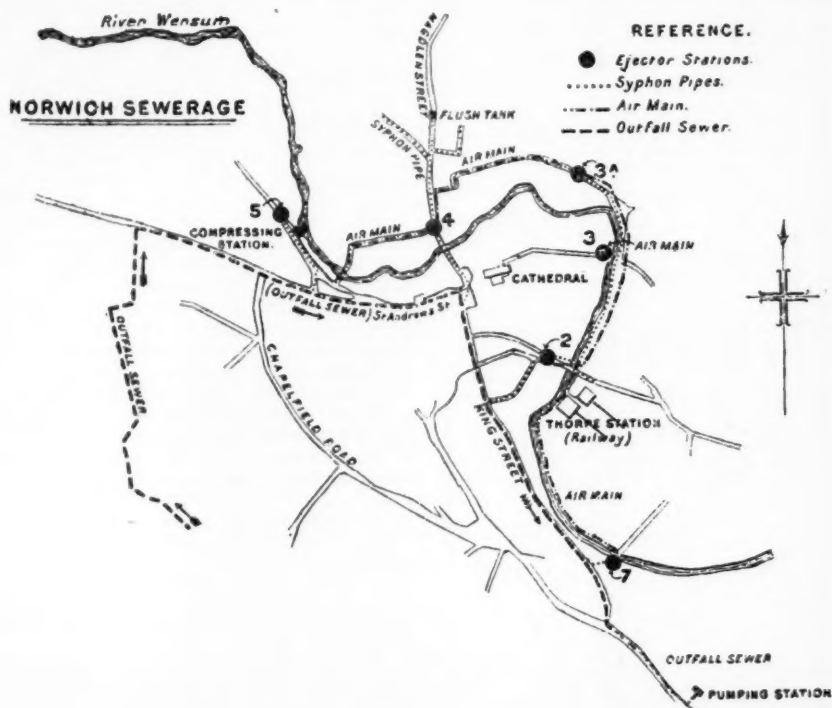
Each turbine drives a set of horizontal air-compressing engines, each set having two air cylinders 15-in. diameter, 18-in. stroke, and able to compress 650 cubic feet of free air per minute to a pressure of 18 lb. per square inch, when the turbine is using 30,000 gallons of water per minute.

boiler, heated with town refuse burnt in two furnaces constructed by the Horsfall Refuse Furnace Syndicate. These works adjoin the air-compressing station, and form part of the New Mills property. Before the Victor turbine was substituted for the old water wheel, nine sluices were provided, the largest being 6 ft. by 4 ft. 6 in. deep, with a combined area of 182.5 square feet. They were, however, very difficult to open, and when heavy floods occurred some of the smaller openings became choked by *debris*. Sir John Hawkshaw recommended, in 1879, that they should be enlarged, and in the new works connected with the Victor turbines care was taken to

provide large sluices of modern design. The waste water sluice is of the well-known Stoney type, 14 ft. 3 in. wide, 8 ft. deep, and in addition to this two sluices have been provided behind each of the turbines, 12 ft. 6 in. wide by 5 ft. high, giving a total sluice area of 239 square feet, without reckoning the port area of the turbines themselves.

As the new buildings fronting the direction of the flow of the river are narrower in their width than the old buildings, there

Two air receivers, 7 ft. diameter, 20 ft. high, are provided in the engine-house, and all the compressed air passes through these, being thereby cooled and dried before it enters the air mains. It is estimated that the cost of the whole scheme will be £164,000, and the works are being carried out by Mr. A. E. Collins, the city engineer, Messrs. Shone and Ault, of Westminster, being the consulting engineers for the Shone ejectors and machinery in connection therewith. The contractors for the Shone ejectors, air-



remains ample room for further extension of the sluices hereafter, if those now provided should prove to be inadequate during periods of heavy floods.

The compressed air is conveyed from the compressors in the air-compressing station to Lower Westwick street through a 9-in. cast iron socket pipe, and from that point the air pipes are gradually reduced in size to correspond to the volumes of air to be conveyed by them to the various ejector stations.

compressing machinery and turbines, air and sealed sewage mains, were Messrs. Hughes and Lancaster, of Westminster and Ruabon. Contracts for the sewers in the various districts have been placed with Messrs. Monk and Newell, of Liverpool, and Messrs. B. Cooke & Co., of London.

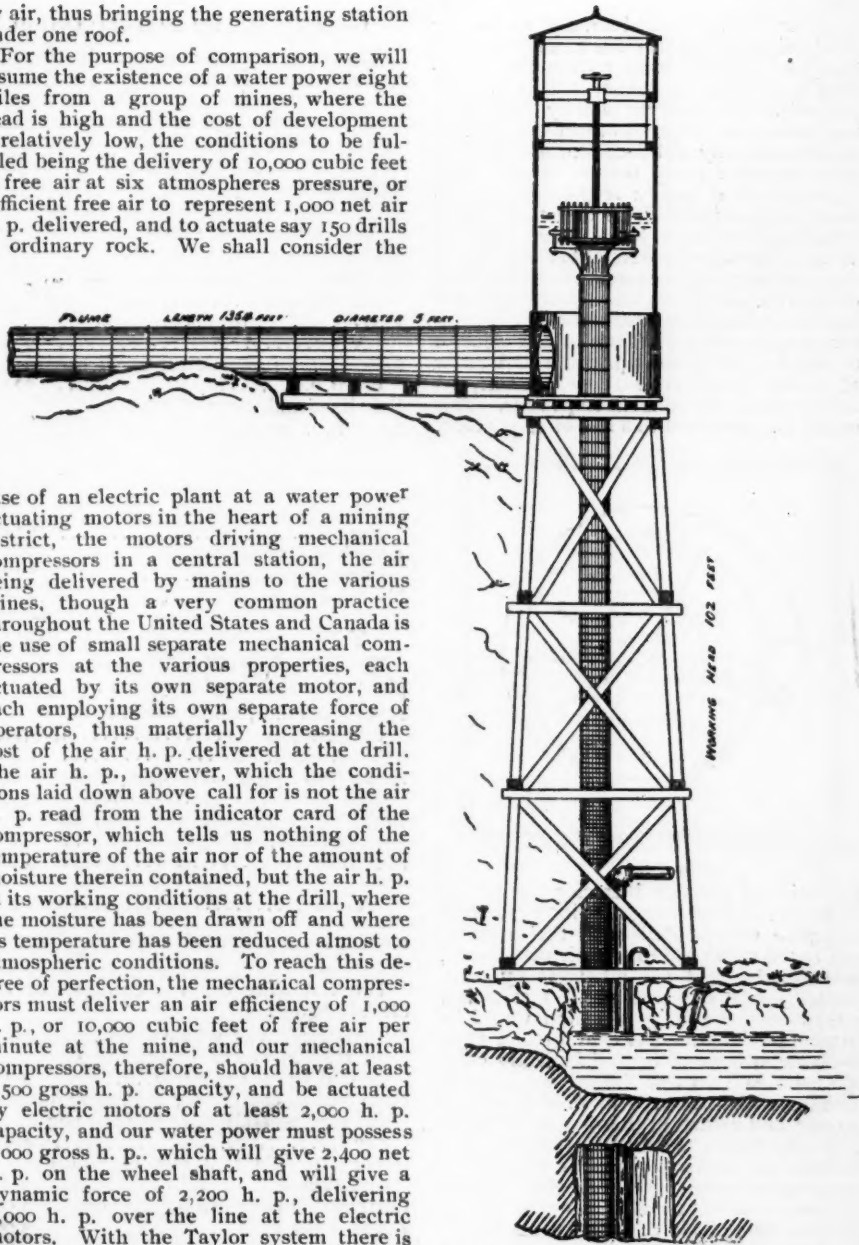
The particulars of the various ejector stations, with the population of the ejector districts, are shown in the table above.

Our illustrations, taken with the preceding article, are self-explanatory.—The Engineer.

by air, thus bringing the generating station under one roof.

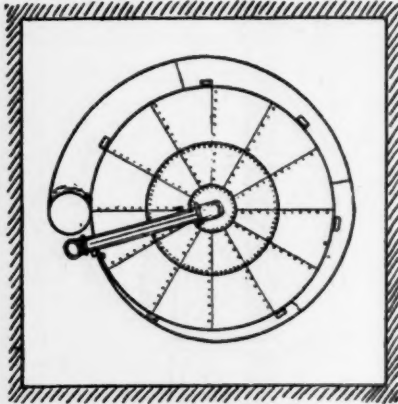
For the purpose of comparison, we will assume the existence of a water power eight miles from a group of mines, where the head is high and the cost of development is relatively low, the conditions to be fulfilled being the delivery of 10,000 cubic feet of free air at six atmospheres pressure, or sufficient free air to represent 1,000 net air h. p. delivered, and to actuate say 150 drills in ordinary rock. We shall consider the

case of an electric plant at a water power actuating motors in the heart of a mining district, the motors driving mechanical compressors in a central station, the air being delivered by mains to the various mines, though a very common practice throughout the United States and Canada is the use of small separate mechanical compressors at the various properties, each actuated by its own separate motor, and each employing its own separate force of operators, thus materially increasing the cost of the air h. p. delivered at the drill. The air h. p., however, which the conditions laid down above call for is not the air h. p. read from the indicator card of the compressor, which tells us nothing of the temperature of the air nor of the amount of moisture therein contained, but the air h. p. at its working conditions at the drill, where the moisture has been drawn off and where its temperature has been reduced almost to atmospheric conditions. To reach this degree of perfection, the mechanical compressors must deliver an air efficiency of 1,000 h. p., or 10,000 cubic feet of free air per minute at the mine, and our mechanical compressors, therefore, should have at least 1,500 gross h. p. capacity, and be actuated by electric motors of at least 2,000 h. p. capacity, and our water power must possess 3,000 gross h. p., which will give 2,400 net h. p. on the wheel shaft, and will give a dynamic force of 2,200 h. p., delivering 2,000 h. p. over the line at the electric motors. With the Taylor system there is but the one transformation, that from the



Air Compressor Plant Installed at Ainsworth.

water to the compressed air, and no moving mechanism is used in the transformation. The water rapidly flowing down the down-flow pipe entrains the air, which is compressed in the receiving tank by the returning column of water, and from this tank it is automatically delivered absolutely free from moisture ready for use at the drill. The amount of loss in transmission is almost inappreciable if we care to invest a sufficient amount in pipe line. In the West, however, where freights are high and the pipe line cost is greater than the sinking of shaft cost, we will figure on a wider drop of pressure in the pipe line. At the compressor we will have a shaft sunk deep enough to produce 125 pounds pressure and allow 45 pounds loss of pressure in the line, delivering at the terminal at 80 pounds. This would be equivalent to a loss of 12 per cent.



PLAN

Reduction of pressure increases the volume of the air, and by using a 15-inch wrought iron pipe we can deliver at the terminal end 10,500 cubic feet of free air per minute, isothermally, and not adiabatically compressed, as in the case of all mechanical compressors, the h. p. of which would be rather more than 20 per cent. greater than the same volume of air adiabatically compressed. With these losses we should, therefore, require 1,250 h. p. at the compressor, and a gross h. p. in water of 1,700 h. p. By raising the initial pressure to 200 pounds, and making a drop of pressure of 100 pounds in the pipe line, which would represent a loss of about 19 per cent. due to friction, the 1,000 h. p. could be carried in a 12-inch main, thus saving one tenth in weight of iron in the plant.

1—ORIGINAL COST OF INSTALLATION.

The cost of water-power development varies with the local conditions, and for the sake of comparison we will take a water power having a high head, where the power can be developed, exclusive of the water-wheel cost, at \$20 per h. p. The following will be the cost of the electric plant, according to the figures given in Dr. Louis Bell's "Electrical Power Transmission," 1897:—

Electric plant, 3,000 gross h.p., at \$20 per h.p.	\$ 60,000
2,200 h.p. electric generators, at \$12 per h.p.	26,400
2,200 h.p. in transformers, at \$10 per h.p.	22,000
Pole lines and wires, eight miles.	35,000
2,750 h.p. in water-wheels, at \$15 per h.p., set in place.	41,250
Station building and equipment	10,000
2,000 h.p. step-down transformers.	22,000
2,000 h.p. in motors, at \$12 per h.p.	24,000
1,500 h.p. compressor plant, set up in place.	75,000
Miscellaneous	20,000

Total\$335,650

The following will be the cost of the air plant under the Taylor system:—

1,750 gross h.p., water power to develop, at \$20.	\$ 35,000
275-foot shaft, 8x8.	10,000
Down-flow pipe and compressor tank.	5,000
Eight miles 15-inch pipe line, all set in place, at \$1.50 per foot.	63,360
Sundries.	10,000

Total.....\$123,360

2.—COST OF MAINTENANCE AND OPERATION.

The following are the expenses of the electric plant:—

Superintendent of whole plant	\$ 3,600
Four men at power generating station, at \$3 each per day.	4,380
Four men at compressor station and sub electric station, at \$3 each per day.	4,380
Repairs to plant, 4 per cent. on capital cost.	13,483
Insurance, 2 per cent. on \$150,000.	3,000
Taxes, 2 per cent.	3,000
Two linemen at \$3 and team at \$1 per day.	2,555

Interest on investment, at 6 per cent.	20,235
Sinking Fund, at 4 per cent	13,488
Clerical work and office expenses....	4,000

Total\$72,126

Should the power transmission plant be at a distance greater than ten miles, then the investment cost would be greater, as a step-down transformer station would be rendered necessary, entailing additional capital and additional operating charges. This brings the annual charge per air h.p. delivered at the drill up to \$72.12, and it is very questionable to-day whether in practice, under the most favorable conditions, a rate as low as this has ever been realized. It should be remembered that in almost every mining camp where electricity is used for the driving of compressors, numbers of small compressors are used on each different property, driven by their own separate motor, each entailing a separate operating force, and this, of course, adds largely to the cost of the air h.p. delivered at the drill. If, for instance, the electric h.p. is rented from a central company at a charge of say \$50 per h.p. per annum, delivered at the motor in the camp, it can be seen from the above figures that the air h.p. delivered at the drill will cost between \$150 and \$200 per annum.

The following are the maintenance and operating expenses of the Taylor air plant:—

Maintenance of pipe line, at 4 per cent.....	\$ 2,534
One man at station to keep racks clean.....	1,000
Depreciation in plant taken at 2 per cent., on account of absence of machinery.	2,267
Management and interest	10,801
Total	\$16,602

Or a h.p. cost of \$16.60 per annum delivered at the drill.

An important point to consider is the relation of the load factor in a power-generating plant. The load factor in a plant reaches its maximum of 100 per cent. when it operates at its full maximum capacity during the whole twenty-four hours. If it operates at less than its maximum capacity, or less than the twenty-four hours, then the load factor cannot reach 100 per cent. The great object in all electric plants is to raise the load factor, because it is found in actual experience that the operating expenses do

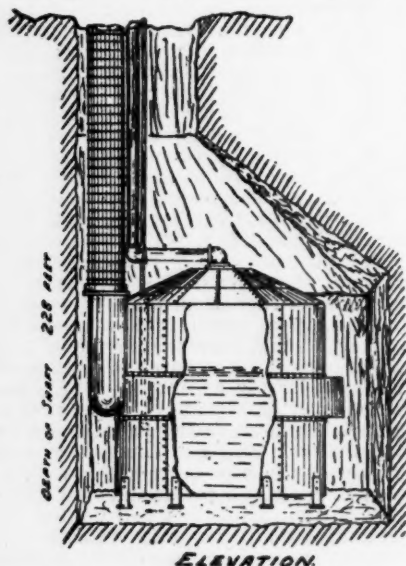
not increase as the load factor increases, nor do they diminish as the load factor diminishes. Very few electric plants attain a load factor exceeding 50 per cent. In the case of the electric plant given above by Dr. Bell, he considers that if it runs on a load factor of 38 it attains all that can be expected. The point is just this: As has been mentioned, the operating expenses in an electric plant do not fall as the load factor falls. If the load factor falls down, say as much as 60 below its maximum, the operating expenses will only fall about 10 per cent. In the case of the Taylor air system, the operating expenses are merely nominal, being in the case considered only \$1,000 for a man to keep the water racks clean, so that this factor of loss due to a low and variable load factor is almost entirely eliminated in the Taylor air plant.

EFFICIENCY OF SYSTEMS.

In the case of the electric proposition there is a series of eight losses from transformation before the drill is actuated in the face of the stopes of the mine: First, from the water to the water-wheel; second, from the water-wheel to the dynamo; third, from the dynamo to the transformer; fourth, from the transformer to the line; fifth, from the line to the step-down transformer; sixth, from the transformer to the motor; seventh, from the motor to the compressor; and eight, from the compressor to the drill. In the hydraulically compressed air plant under the Taylor system we just have two transformation losses—first from the water to the air in the receiving tank, and from the receiving tank to the drill. The Magog, Quebec, plant is actually running with an efficiency of delivered air of 62 per cent., and Professor Nicholson, of McGill College, Montreal, in a very able treatise on the plant, shows that the efficiency should have been 81 per cent. instead of 62, the difference being largely accounted for by a loss due to ineffective separation, 20 per cent. of the air taken down having escaped with the up-cast water. This was due to the small capacity of the separating tank; and, as Professor Nicholson points out, "all future plants will avoid this loss, and we may expect as high an efficiency from this system as when the power is given off at a turbine jack-shaft, when it is not by any means in such a fit state for transmission as it is in the shape of compressed air." Professor W. C. Unwin, F.R.S., author of "The Development and Transmission of Power," says: "I expect that an efficiency of 75

per cent. can be reached when the proportions of the apparatus have been better adjusted. This comparatively large compressor (referring to the Magog plant), is therefore, an example of a very successful application of Mr. Taylor's system. It works almost automatically, and with very little supervision. It has no moving parts and nothing requiring adjustment, and the apparatus will cost very little for maintenance or repairs."

We come now to consider the respective losses in both systems due to transmission. It is generally believed that electricity has a much superior advantage over compressed air for transmission purposes, that is, that there is a much smaller loss of energy over electric wires than through pipe lines. Compressed air has been badly misrepresented in this respect; this loss has been greatly exaggerated, and the catalogues of air-compressing machinery companies have not improved matters any; in fact, they have done more harm than good as regards the interests of compressed air. The tables published in air compressor catalogues usually speak only of the loss of pressure;



they fail to tell us that the loss of pressure is not necessarily, or to the same extent, a loss of power. As Frank Richards, in his work on "Compressed Air," page 33, says: "The actual truth is that there is very

little loss of power through the transmission of compressed air in suitable pipes to a reasonable distance, and the reasonable distance is not a short one. With pipes of proper size and in good condition, air may be transmitted say ten miles, with a loss of pressure of less than one pound per mile. If the air were at 80 pounds gauge or 95 pounds absolute upon entering the pipe, and 70 pounds gauge or 85 pounds absolute at the other end, there would be a loss of little more than 10 per cent. in absolute pressure, but at the same time there would be an increase of volume of 11 per cent. to compensate for this loss of pressure, and the loss of available power would be less than 3 per cent. With higher pressures still more favorable results could be shown." As a competitor with electricity in long distance transmission, it seems almost like scientific heresy to claim for it equal if not greater efficiency; nevertheless the writer claims that within the 20-mile limit compressed air will compare in efficiency with electric transmission, while so far as operating and maintenance expenses are concerned, the electric proposition is not to be compared for a moment with that of air. Over 15,000 h.p. of mechanically compressed air is distributed to-day throughout the city of Paris, France, being transmitted from a series of stations from three to fifteen miles distant, with a loss of 10 pounds pressure in transmission. This compressed air is used for all kinds of purposes; and additional installations are constantly being made to meet the ever-increasing demands.

Professor W. C. Unwin in his work on "The Development and Transmission of Power from Central Stations," page 186, says: "In comparatively short distance transmissions such as those in towns, the loss of pressure in the mains is so insignificant that it may be neglected. In long distance transmissions an accurate estimate of frictional loss is necessary. The author believes that he has shown, using data derived from careful experiments on twenty miles of main in Paris, that long distance transmission of power by compressed air is perfectly practicable." In the work referred to Professor Unwin gives the figures on a 10,000 h.p. plant, where the initial pressure is 132 pounds, and the transmission pipe is 20 miles in length and 30 inches in diameter, and shows that the loss of pressure in such a case would be only 12 per cent., which means a loss of power of less than 6 per cent.

It is not the purpose of the present article to institute a comparison between the work done by mechanical air compressors and the Taylor air compressor, its object being to show the comparison of the latter with electric transmission. As, however, the mechanical compressor becomes a part of the system in the electric proposition, being necessary at the distribution end of the line to convert the electric energy into compressed air, this is the proper place to say a few words as to the relative efficiencies of the product turned out by the mechanical compressor and the Taylor air compressor respectively. The Taylor compressor turns out absolutely dry air—a feat which is impossible of accomplishment by any known mechanical compressor. The great advantages of dry air are sufficiently well known to all air users, so it will not be necessary to dwell on this point here. From the very nature of mechanical compressors, it will never be possible for them to turn out dry air. Owing to the rise of temperature which accompanies all mechanical compression, mechanically compressed air will always contain a higher percentage of moisture than the surrounding atmosphere; in this sense the mechanical compressor acts like a moisture collector, and this moisture is discharged and freezes up in the machinery upon the expansion of the air when used. From actual tests it is found that the Taylor compressor turns out compressed air which is three times drier than the free air of the atmosphere from which it is drawn. This may appear somewhat surprising, but it is nevertheless true. It leaves the compressing tank absolutely dry and cool, its temperature being the same as the water which it carries down. This is the ideal condition to which all compressed air users and manufacturers of air compressing machinery have been striving to attain, and particularly in its application to mining, where compressed air is required for constant use by the drills, will this advantage of obtaining absolutely dry and cool air be found to be an inestimable boon.

4.—RELATIVE SIMPLICITY OF SYSTEMS AND THE SUPERIOR ADVANTAGES OF OPERATING WITH SIMPLE MACHINERY.

In long distance electric power transmission the apparatus used is of a highly unstable character, necessitating as it does constant supervision by skilled men. The multiplicity of transformers, high potential

insulators and other high potential devices in long distance electric propositions renders them exceedingly liable to break-downs, particularly if the transmission line passes through a rough and wooded country. A break-down generally occurs just when the power is most wanted, and when the heaviest load is on. Trouble on the outside line from storms, falling timbers, lightning and other causes is immediately felt at the generating station, with very often disastrous results to the high potential machines and apparatus. If by machinery is implied moving mechanism, such as wheels, shafts, pulleys, belting, gearing, etc., then there is no machinery whatever involved in the Taylor system of air compression. There is not one single moving piece of mechanism in the whole compressing outfit. There is no other system of power generation in the world where these conditions exist; and of all the factors which enter into the consideration of the economic production of the power at the present day, the one involved in moving machinery parts is the most important. The aim of modern machinery practice is to obtain the utmost possible simplicity of moving parts consistent with efficient operation. What does the absolute absence of moving machinery mean in a system of power generation? It means the absolute elimination of all repairs and stoppages in the system; and those who have had to do with the management of power machinery can realize what this means from an economic point of view, and can also realize the trouble and annoyance dispensed with by the breaking down of moving machinery very often at the most critical times. In the Taylor air compressing system there is not a single moving axle or shaft, not a single moving wheel or gear, and not a single rod or piston of any kind. The system is as stated, absolutely devoid of anything whatever in the way of moving mechanism; and yet it develops and delivers any quantity of compressed air in a more efficient and perfect condition than if engines and compressors turned it out.

UTILIZATION OF SMALL MOUNTAIN POWERS.

There is one factor in this new form of hydraulically compressing air which will prove to be of great value in the utilization of the numerous comparatively small streams found in the mountainous mining districts of the west. It often occurs that

in the course of a stream extending over a distance of five miles a series of falls can be obtained, aggregating about 1,000 feet, the stream gathering to itself as it flows downward additional supplies of water from various gulches. To improve these small powers by turbines involves, if the whole head is to be taken advantage of, the loss of the drainage area below the point of diversion, which oftentimes amounts to a large percentage of the whole, or the installation of three or four operating stations, the expense and maintenance of which make the power cost prohibitive. With the Taylor system every pound of water in the whole length of the stream can be used, because compressors can be installed at every few hundred feet, and the air generated by these compressors delivered into a common pipe line for distribution to the mining camp; or, in order to save expense in the sinking of shafts the upper compressors can make the air at a low pressure and this air can be carried to the lowest compressor, the lowest compressor being used as a "booster" to raise the pressure so that it can be economically transmitted. In this way the entire h.p. of the stream on every foot of its length can be utilized without any addition to the operating expenses and with only a comparatively small increase to the installation cost. The system in other words has all the elasticity of electricity with elimination of its operating and maintenance expenses, and the volume of air transmitted in the pipe line can be doubled even after the compressors are built, by the construction of a second compressor to "boost" up the air made by the first compressor to a higher pressure.

It will also be observed that the Taylor system is by far the more economical in the use of water in the cases we have been considering; and this is an important item with the mountain streams of the West, whose water supply is limited, and for the use of which certain fixed charges are made by the Government according to the quantity used. Every year adds to the industrial value of the streams, and therefore any system of power development which involves the more economical use of the water is the system to which preference must be given.

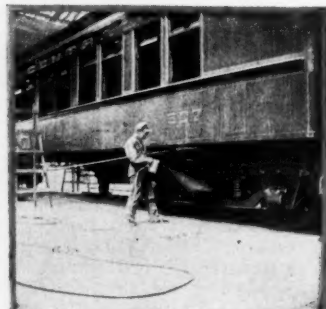
Compressed air is the ideal applied power, and particularly is this the case under the Taylor system. The plant where it is installed is like a part of nature herself, the water being simply directed to flow through an iron or wooden pipe instead of through its former channel. There is practically no wear upon the system, and the power ma-

terials are drawn from nature's inexhaustible storehouse. It is incomparable in its simplicity, and is destined to bring compressed air as an applied power to its deserved and proper place—the very front rank in the mechanical world—a consummation impossible of attainment with any known system of mechanical compression at the present day.

Pneumatic Painting Machines.

The interesting subject of "painting by compressed air" has the faculty of keeping before the public as conspicuous as any other line of compressed air work. The August issue of the Railroad Car Journal prints the following regarding it:

"The ever progressive Louisville & Nashville Railroad Company is improving the appearance of their property along the line of the P. & A. division, between Pensacola



Painting Car Trucks.

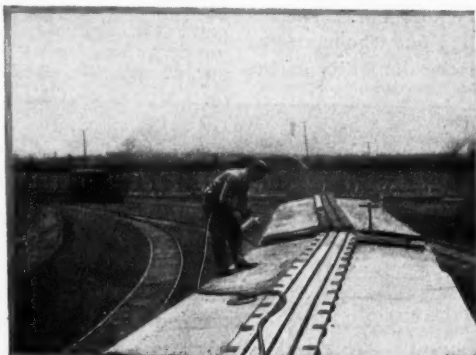
and River Junction, by having all the section houses and a number of depots and water stations painted. The handsome new freight warehouse in this city, now rapidly nearing completion, is also being painted, all this work being done under the supervision of Mr. C. D. Beyer, the foreman painter of the L. & N. Railroad shops in this city. There are about 85 buildings, the fresh, new paint on which will be very gratifying to the travelers along the line."

At the M. C. B. Convention, held in June

last, a discussion was opened on this subject by Mr. F. W. Brazier, Assistant Superintendent of Machinery of the Illinois Central Railroad.

The topic assigned to me to speak on,

benefit of this association, I sent out inquiry letters all over our system to have our foremen painters inspect any and all cars that they could find that were painted with air. I might mention the fact that



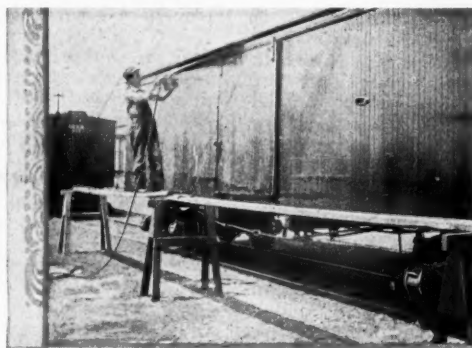
Painting Top of Car.

"The Durability of Paint Applied to Freight Cars by Compressed Air," as compared with paint applied by the brush, is a question which our company has taken great interest in. We are at present repainting about 400 cars per week with com-

pressed air. We found most of the old school painters opposed to the air system when we inaugurated it. From one of our Southern States our painter reports as follows:

Vicksburg, Miss.

"In reply to your letter as to the durability of paint applied by compressed air,



Touching-Up the Eaves.

pressed air. We are positive that we are getting better results, a saving in labor, and our cars are painted more thoroughly than with a brush. We have cars that have been painted about two years, and in order to get reliable information for the

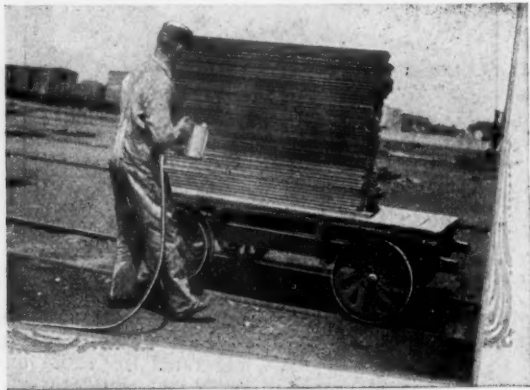
and the old method by brush, I would state that after making close observation of several cars done by air and by brush, I find very little difference in them, and if any, it is in favor of cars done with air.

(Signed)

J. GLASS,
Foreman Painter."

Other letters follow which bring forth about the same results. Many of them acknowledge their skepticism in the beginning as to the chances of this method becoming a permanent institution in the painting of railroad equipment. The experience of nearly every one who has tested the capabilities and the durability of the

fixed plant for the underground trolley are, roughly speaking, as much on a route where there is a car service every five minutes, as where cars must be run every forty seconds. There are routes of travel however, especially on crosstown lines, where mechanical traction is desirable for the better public service and to stimulate travel, but where the underground trolley would perhaps not pay, or, at any rate, would not pay until there



Painting Edges of Boards.

pneumatic painting machines has been of a highly satisfactory nature.

In the trade, painting machines are being supplied by the Chicago Pneumatic Tool Co., and their actual working is shown in the illustrations. They require only one hose—that for air—as the paint is sprayed directly from the machine. Its convenience is evident and the testimony of practical painters will do much toward promoting its use wherever painting is done.

Col. Prout on Pneumatic Traction.

A very interesting and timely article appeared in the *New York Times* of Sunday, July 24th, discussing "The Motive Power of the City Railroads of New York," contributed by the editor of the *Railroad Gazette*, Mr. H. G. Prout. In it he notes the progress being made in this city in street railroad work, and indicates the change from horses and cable to underground trolley and compressed air; we extract as follows:

"But the whole story is not yet told, and perhaps the present state of the art is to some extent only a temporary state. The interest cost and the labor charges of the

has been a considerable growth of passenger movement on such lines. This is still more true of a great many towns smaller than New York City. So it is desirable to have a set of independent, self-contained motor cars that can run on horse car tracks as they now exist, and save the cost of the underground trolley construction. Still further, such independent, self-contained motor cars could be diverted to any route, and interpolated between electric or cable cars, and so aid in the development of the logical routing of cars according to the demand of the hour.

But for such service the steam motor is out of the question, for reasons which need not be developed here. The same is true in the present state of the art of the electric storage battery motor. The same is probably true of the hot-water motor. And so we are brought around to compressed air. There are reasons to suppose that a compressed air engine will do street railroad service with acceptable speed, reliability and economy. We cannot admit that this is demonstrated yet, but there are reasons to suppose that it is true. There is considerable accumulated experience in mines, on cotton wharves, and on experi-

mental surface lines which justifies such a hope at least, and compressed air motors have been improved in design since that experience was begun. There has been no important experiment with the latest designs of such motors, and compressed air has never been put to the actual work of hauling city street cars in a large and responsible way. Such an experiment will soon begin in New York City. The Metropolitan Street Railway Company will, within a few months, have a line of compressed air motors in service between the ferry at West Twenty-third Street and that at East Thirty-fourth Street, by way of Twenty-eighth and Twenty-ninth Streets. It will also have a service by compressed air between the West Twenty-third Street ferry and the Grand Central Station. This will be a thoroughly modern and scientific equipment, and here an actual demonstration will be carried out on a large scale. This demonstration will show whether compressed air can fill the requirements of speed, power, reliability and economy, as well as electricity or steam can do in like situations. The social and financial results of that demonstration may be very important; to an intelligent public they may be deeply interesting, and so it worth while to keep close watch of them.

Mr. Isham Sedgwick, Richmond, Ind., has invented a method where as many as fourteen windmills on a single tower can be geared to the same shaft, and at the same time give the full power of the mills to that shaft. The construction will be as stable as a house and he reckons as follows:

"14 twenty foot wheels in an 18 mile wind will give about 70 h.p. The outfit would probably cost \$3,000, and would average that much power for 20 years at almost no cost for expenses. The wind on Jersey coast will average a much better speed than 18 miles per hour. One man could attend 20 such plants. Now, if air compressors can be run by such power, the question of storage of power can certainly be met, and the question of economical power either direct from the compressed air or from the use of electricity is at once solved. Cheap light and heat comes with this combination. I have not taken out patents yet but have secured the matter so that I can lay the plan before interested parties. Competent mechanics agree that my plan is entirely practical."

Mr. Sedgwick is desirous of being in

communication with people willing to investigate the plan and who will be able to utilize it.

Mrs. Blinks—"I've just been reading about the work of that dreadful Vesuvius, George, and there was something I wanted to ask you."

Mr. B.—"All right; make it as easy as possible."

Mrs. B.—"Why, it's just this. It's fired by compressed air, isn't it?"

Mr. B.—"Eh? Oh, yes."

Mrs. B.—"Well, what I wanted to know was where do they get it?"

Mr. B.—"Get what?"

Mrs. B.—"The compressed air."

Mr. B.—"Oh, that's what you want to know, is it?"

Mrs. B.—"Yes. It's imported, isn't it?"

Mr. B.—"Eh? Oh, yes, of course. They import it in bottles, and there's a blue label on 'em, and it isn't good until it's been in the cellar seven years, and the custom house stamp must be carefully affixed, and it must lie on this side with care, and you have to be extra particular not to shake it before corkscrewing it, and the froth must be carefully blown off with one blow, and—but there, I'm late for my club engagement.—*Cleveland Plain Dealer.*"

COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSED AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz: all communications should be written on one side of the paper only: they should be short and to the point.

ST. STEPHENS, S. C., June 25, 1898.

PUB. COMPRESSED AIR,

No. 26 Cortlandt St., New York.

DEAR SIR:

I have invented an entirely new and distinct method of compressing air and not being financially able to develop same I would like to correspond with parties who would be willing to aid in fully completing and thoroughly testing my plans or theory.

My new form of compressing air is novel and can be done with little or no expense after the machine is once charged. The power to run it is derived from the air it compresses. In other words, it is self-supporting, running itself without the aid of any other power, and while it uses the air it compresses to run itself it does not use all, leaving a surplus for other purposes, and if properly developed I am confident there would be only a very small per cent. used or consumed in the operation.

I know the above is a very big assertion, yet I make it in the full confidence that I will be able to demonstrate by theory and practice that my assertions are based on good grounds. Every principle employed being understood except one and that is also thoroughly understood in another capacity.

If you will kindly publish some notice in your paper it might be the means of enabling me to obtain aid in bringing out a process of compressing air that would be of value to the public and also to myself. Yours truly, H. B. TAYLOR.

ALPHABETICAL LIST OF PNEUMATIC INVENTIONS

For which United States patents have been granted. Prepared for COMPRESSED AIR from official records by GRAFTON L. MCGILL.

APPLIANCE.	NAME OF INVENTOR.	DATE OF ISSUE.	No.
Air Compressor	Avery.....	Sept. 20, 1892	482,775
"	Babcock.....	July 17, 1894	523,064
"	Beck.....	June 7, 1892	476,723
"	Birner & Messing.....	May 29, 1894	520,405
"	Blake.....	Feb. 12, 1895	534,192
"	Brotherhood.....	Feb. 20, 1894	515,282
"	Champ.....	Jan. 30, 1894	513,556
"	"	Feb. 27, 1894	515,516
"	"	July 31, 1894	523,830
"	"	Aug. 13, 1895	544,456
"	"	Aug. 13, 1895	544,457
"	"	Aug. 13, 1895	544,458
"	"	Aug. 13, 1895	544,459
"	"	Oct. 15, 1895	547,768
"	"	Nov. 3, 1896	570,540
"	Chaquette.....	Oct. 29, 1895	548,800
"	"	Aug. 11, 1896	565,429
"	Clark.....	June 2, 1891	453,374
"	"	April 14, 1896	558,041
"	Clayton.....	Feb. 26, 1895	534,814
"	Crabtree.....	Nov. 30, 1897	594,524
"	Cummings.....	Oct. 8, 1889	412,474
"	Davey.....	Aug. 27, 1889	409,773
"	DeLaval.....	Dec. 19, 1893	511,086
"	Dillenburg.....	Aug. 30, 1892	481,850
"	DuFaur.....	June 2, 1896	561,160
"	Duffy.....	Oct. 1, 1895	547,338
"	Dunn.....	April 19, 1892	473,302
"	Durand.....	Nov. 19, 1895	550,163
"	Dyer.....	June 22, 1897	585,090
"	Elliott.....	Sept. 29, 1896	568,433
"	Eloheimo.....	Aug. 26, 1890	435,034
"	Farrell.....	July 19, 1892	479,260
"	Fasoldt.....	Aug. 23, 1892	481,527
"	Fitzpatrick.....	April 30, 1889	402,517
"	Flindall.....	July 6, 1897	585,955
"	Flood.....	May 8, 1894	519,383
"	Fogg.....	March 14, 1893	493,263
"	Funk.....	Dec. 24, 1889	417,717
"	Githens.....	July 7, 1896	563,477
"	Griffiths <i>et al.</i>	Dec. 4, 1894	530,335
"	"	Oct. 15, 1895	547,882
"	"	Feb. 2, 1897	576,364
"	Guillemet.....	Sept. 6, 1892	482,040
"	Gustafson.....	Nov. 21, 1893	509,220
"	Guthrie.....	Dec. 17, 1889	417,482
"	Guyser.....	May 26, 1896	560,987
"	Haines.....	March 15, 1892	470,934
"	"	Aug. 2, 1892	480,193
"	Hanford.....	May 3, 1892	474,296
"	Hanston & Burdan.....	March 29, 1892	471,766

PATENTS GRANTED JUNE, 1898.

Specially prepared for COMPRESSED AIR from the
Patent Office files by Grafton L. McGill,
Washington, D. C.

606,428—Air-Compressor. Frank Richards, New
York, N. Y.

Water jackets are surrounded by a plurality of upright cylinders having pistons therein. The base is provided with an open bottom and comprises a flat top plate and a second plate below the latter, leaving a water-chamber between said plates. Connections are arranged between the chambers and water-jackets. The crank-shaft is supported in boxes or bearings arranged on pillars, the latter being cast integral with the plate forming the top-plate of the cylinders.

JULY, 1898.

606,732—Hydraulic Air Compressor. Noack &
Grossman, Cleveland, Ohio.

An air-and-water chamber is provided with a water waste-port in its bottom. A main controlling valve chamber is supported above the waste-port to form a water outlet between its lower edge and said port, while its upper end has communication with the water inlet. A port is located in the side of this chamber communicating with the interior of the air-and-water chamber. The main controlling valve, having play in said chamber, is constructed of such length as to remain partly or entirely within the valve chamber when lowered to close the water outlet, cover the waste-port and uncover the port in the side of the valve chamber. When raised, this valve uncovers the outlet and waste-port and closes the port in the side of the valve chamber. A piston and chamber are connected to actuate the main controlling valve, while a primary valve controls the water for said piston and chamber, by the rise and fall of the water in the air-and-water chamber.

606,733—Hydraulic Air Compressor. Noack &
Grossman, Cleveland, Ohio.

In this compressor the air-and-water chamber is provided with an air-inlet and outlet at its top, and a water inlet and outlet at its bottom. The main controlling valve controls the water inlet and outlet for the chamber, and has an actuating piston connected to it by a stem formed with a water passage through it and the top of the piston. The chamber of this piston has an inlet for the actuating water at one end and a water outlet at the other end, while communicating with said outlet is the lower port of a primary valve chamber, the latter being open at both its ends and having a waste-port near its upper end. Means are provided for raising and lowering the primary valve at the extreme lower and upper water level in the air-and-water chamber, the valve being provided with a packing piston at both its upper and lower ends, the latter permanently below the port communicating with the outlet from the actuating piston chamber. A distributing piston plays at both sides of the waste-port of the valve chamber.

607,371—Air Brake. Wm. Hirst, Trenton, N. J.

This invention has for its object the association or combination of the function of pressure-retaining with the other functions of the triple-valve, that is, to provide means whereby the triple-valve

may be moved into the position to recharge the auxiliary reservoir and at the same time automatically retain the pressure in the brake cylinder. Means are provided for locally venting the train pipe to effect quick action which increase in sensitiveness as the pressure in the auxiliary reservoir and train-pipe decreases.

606,708—Air-Brake. Murray Corrington, New
York, N. Y.

A triple-valve device is provided with an emergency passage for venting the air from the train-pipe, and a piston, one side of which closes the mouth of said passage, while its sides are normally partly or wholly exposed to fluid pressure. One part of the triple-valve opens a passage for releasing the pressure from one side of said piston. Thus the piston is moved by the pressure on its other side away from its position of rest to open the emergency passage.

606,712—Air-Brake. L. F. Guillemet, San Francisco, Cal. Assignor to the Westinghouse
Air Brake Co., Wilmerding, Pa.

In this triple-valve device, having the usual connections with the train-pipe and an auxiliary reservoir, a movable abutment is provided, the latter being normally exposed on its opposite sides to pressure from the train pipe. A graduating valve, operated by this abutment, controls the release of fluid from the auxiliary reservoir to the brake-cylinder. A second separate movable abutment also operates a valve controlling the exhaust of fluid from the brake-cylinder.

606,752—Hot-Air Furnace. H. L. Wingert, Montpelier, Ohio.

Two radiators having air-tubes therein are located above the fire-box, the lower one being in communication with the rear of the fire-box and the upper one in communication with the rear and front of said lower radiator. The forward ends of the radiators are separated from each other, leaving a space in which an oven is located. Doors are arranged in the front of the furnace for access to the fire-pot and separate doors for access to the front ends of the radiators, while one is located between the radiator doors for access to the oven between the radiators.

607,195—Valve-Gear for Air Compressors. E. T.
Sederholm, Chicago.

The valve stem carries a piston and a dash-pot, the latter being operated by the valve-gear and adapted to be moved away from the piston, allowing the valve to open and to cushion the valve in the opening movement. A spring returns the dash-pot to its closed position while the latter is in operative contact with the piston to close the valve.

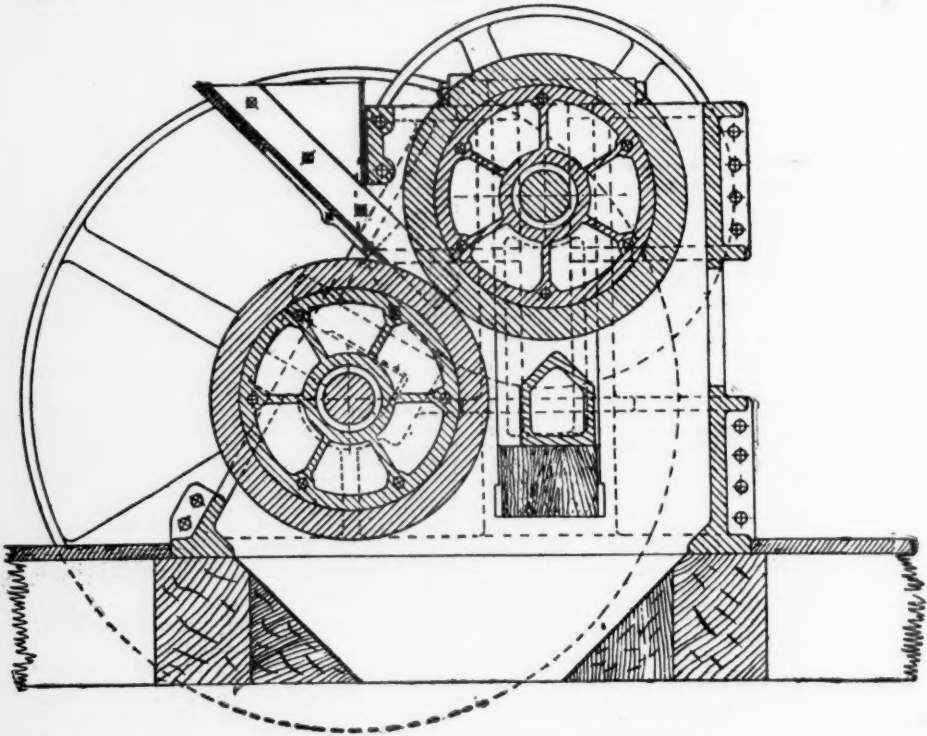
607,793—Hot-Air Furnace. J. T. & J. K. Brien,
Hoosick Falls, N. Y.

The base is provided with an ash-pit, having horizontal flues extending from front to rear on opposite sides thereof. A casing is mounted on the base and is provided with a front aperture. Vertical flues connect at the lower end with the base-flues. An upper flue box is located within the casing and removable through the front aperture therein. Its flues extend from front to rear, and it is provided with bottom apertures communicating respectively with the fire-pot and the upper ends of the several vertical flues.

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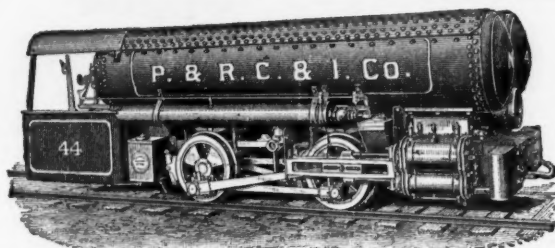
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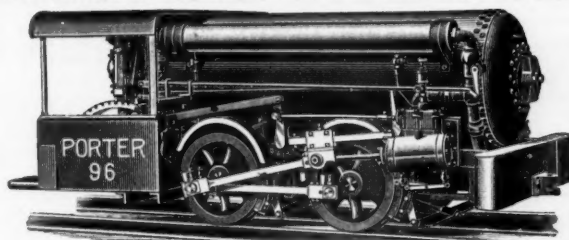
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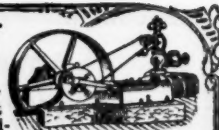
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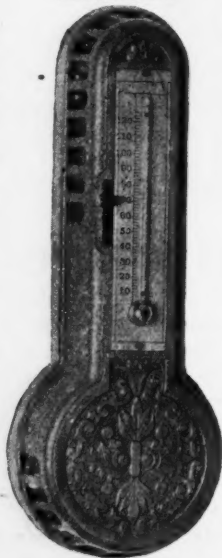
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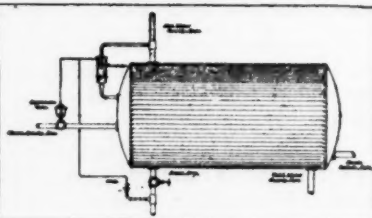
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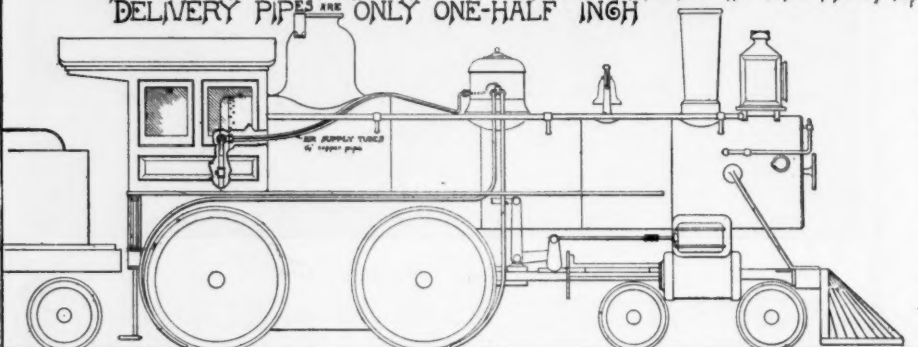
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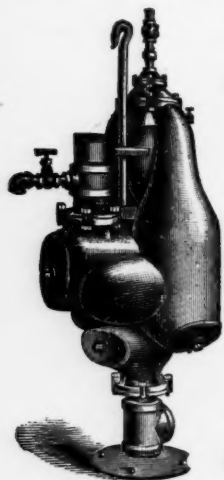
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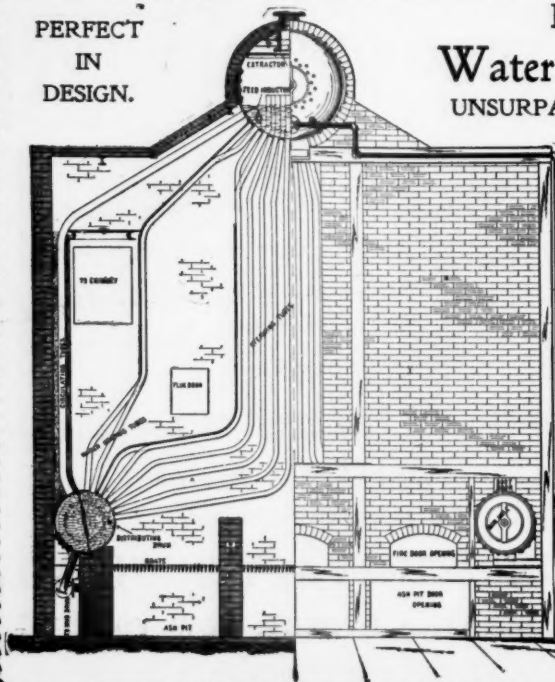
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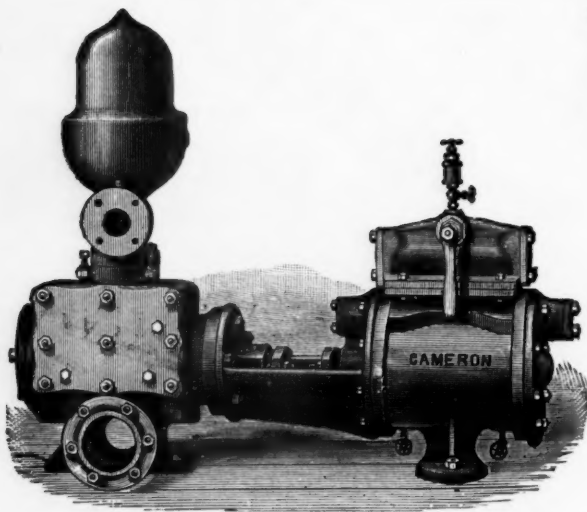
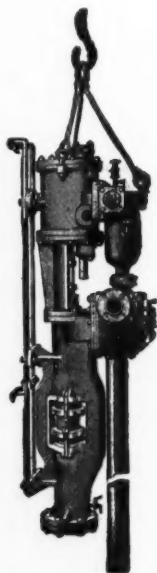
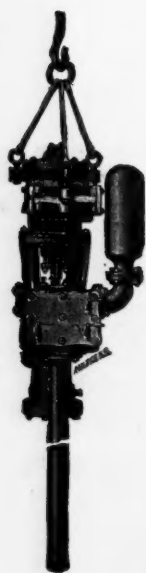
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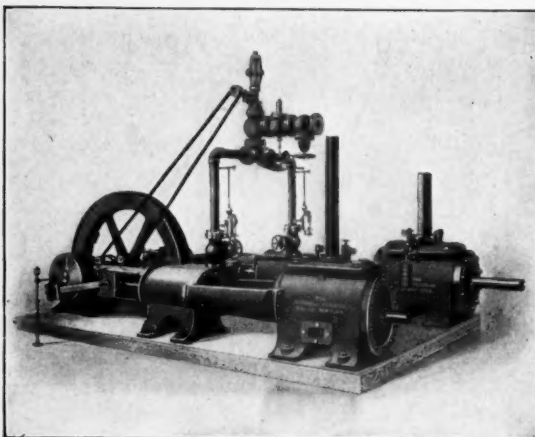
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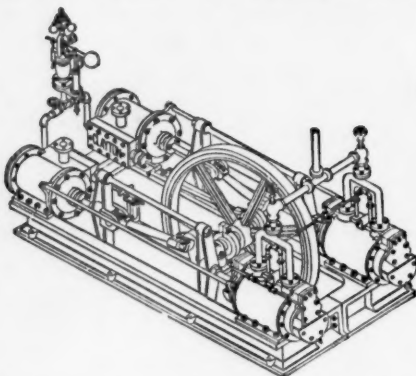
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